



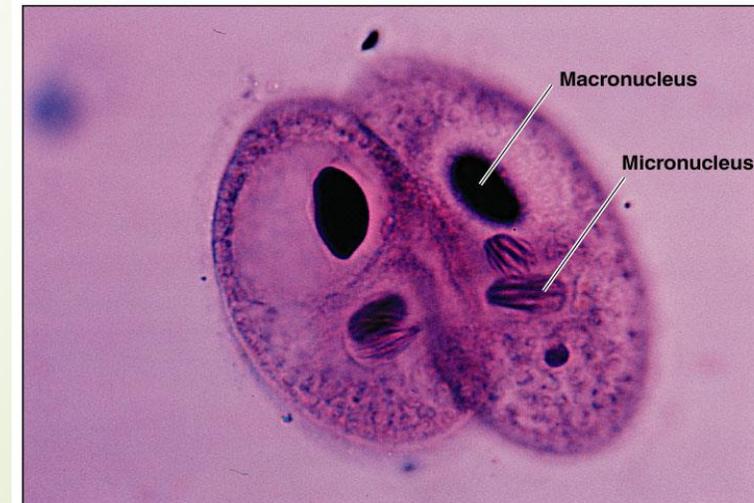
Lecture (8)

Protozoa



Protozoa

- Eukaryotic
- cell is much larger and more complex than prokaryotic cell and contains a variety of organelles (Golgi apparatus, mitochondria, ribosomes, etc).
- Unicellular
- They lack a cell wall
- Vegetative form is a trophozoite



Protozoa

- Asexual reproduction occurs by mitotic division.
- Some have true sexual reproduction with zygote formation
- Protozoa include both autotrophs and heterotrophs. They include free-living and parasitic forms.
- Protozoa move mainly using cilia or flagella and by using pseudopodia
- Cilia also used for feeding in many small metazoans.

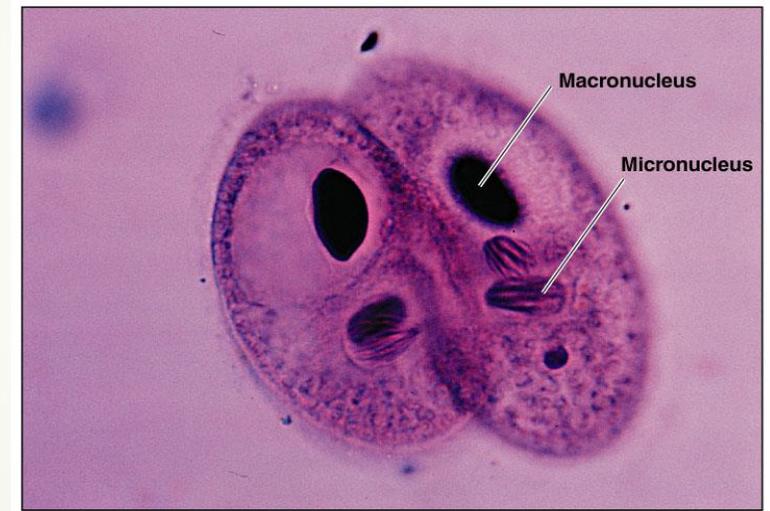


Figure 12.16



The Protozoa

- There are about 45,000 protozoan species; around 8000 are parasitic, and around 25 species are important to humans.
- Diagnosis - must learn to differentiate between the harmless and the medically important. This is most often based upon the morphology of respective organisms.
- Transmission - mostly person-to-person, via fecal-oral route; fecally contaminated food or water; other means include sexual transmission, insect bites or insect feces.

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graph TD; A[Protozoa] --- B[Sarcodina]; A --- C[Mastigophora]; A --- D[Ciliata]; A --- E[Sporozoa];
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Protozoa

Sarcodina

Mastigophora

Ciliata

Sporozoa



Protozoa is classified into four subdivisions according to the methods of locomotion.

- **(Sarcodina) The amoebae move by means of pseudopodia.**
- **(Mastigophora) The flagellates typically move by long, whiplike flagellae.**
- **(Ciliata) The ciliates are propelled by rows of cilia that beat with a synchronized wavelike motion.**
- **(Sporozoa) The sporozoans lack specialized organelles of motility.**

Protozoa that enter the body via ingestion have two morphological forms

- Trophozoite
 - Feeding and reproducing stage that lives within the host
- Cyst
 - Infective form that survives in the environment
- Trophozoites undergo encystment before leaving the host in feces
- Parasites presented based primarily on their mode of locomotion
 - Ciliate, amoebae, flagellates



The Protozoa

- **Trophozoite** - the motile vegetative stage; multiplies via binary fission; colonizes host.
- **Cyst** - the inactive, non-motile, infective stage; survives the environment due to the presence of a cyst wall. Cysts do not multiply, however, some organisms divide within the cyst wall.



The Protozoa

Diagnostic Features:

- Nuclear structure - important in species differentiation.
- Size - helpful in identifying organisms; must have calibrated objectives on the microscope in order to measure accurately.
- Cytoplasmic inclusions - chromatoid bars (coalesced RNA) food vacuoles containing bacteria, yeast, etc.
- Appearance of cytoplasm - smooth & clean or vacuolated.
- Type of motility - directional or non-directional; sluggish or fast.

The Protozoa

Nuclear Structure:

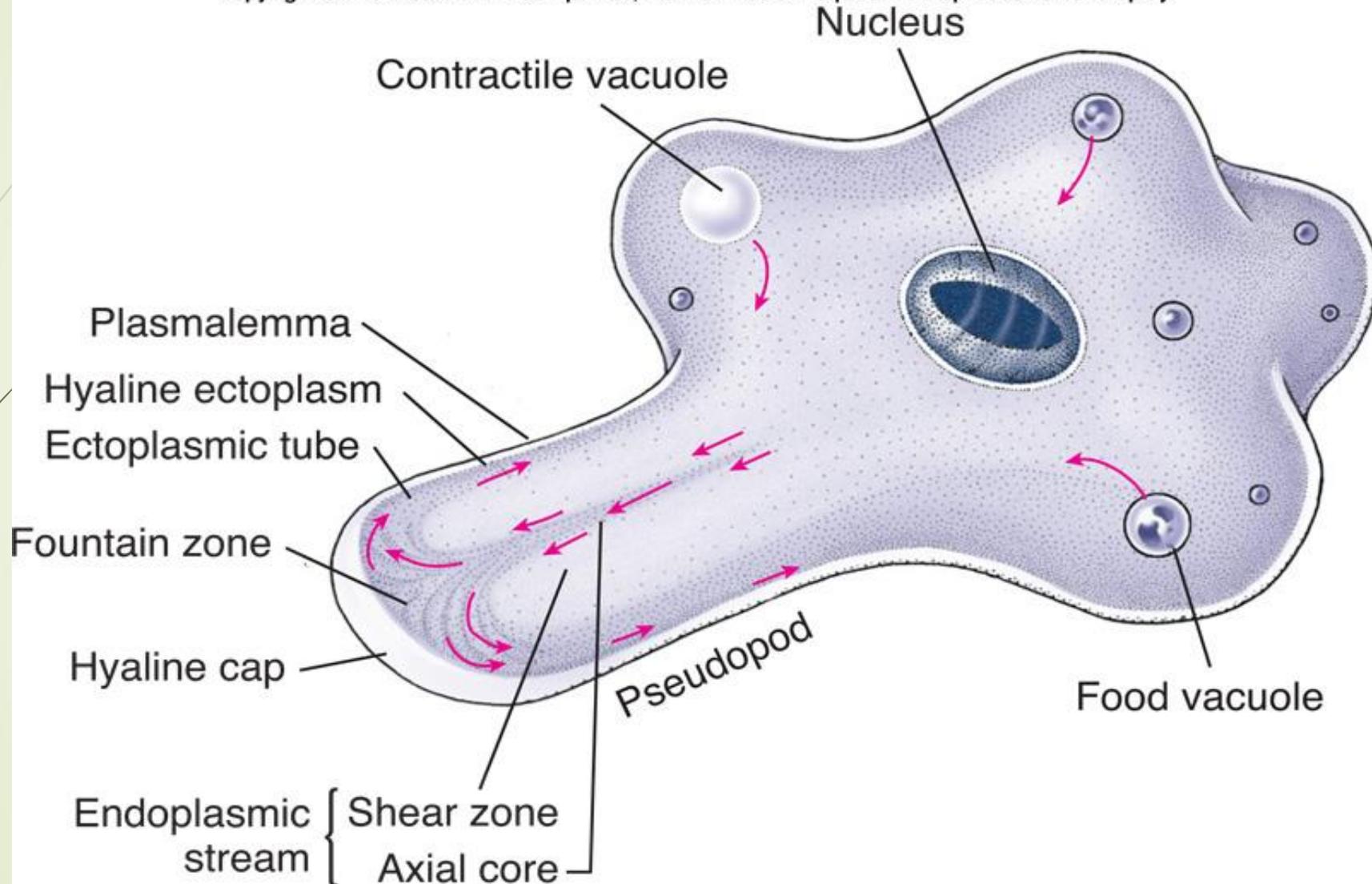
- ▶ **Chromatin** - nuclear DNA. Present as “peripheral” chromatin and the karyosome.
- ▶ **Karyosome** - a small mass of chromatin within the nuclear space. Also called “endosome” or “centrosome.”
- ▶ **Peripheral Chromatin** - chromatin adhering to the nuclear membrane.
- ▶ **Nuclear membrane** - membrane surrounding all nuclear material.



Pseudopodia

- Amoeboid movement involves endoplasm and ectoplasm. Endoplasm is more fluid than ectoplasm which is gel-like.
 - When a pseudopodium forms, an extension of ectoplasm appears and endoplasm flows into it and fountains to the periphery where it becomes ectoplasm. Thus, a tube of ectoplasm forms that the endoplasm flows through. The pseudopodium anchors to the substrate and the organism moves forward.
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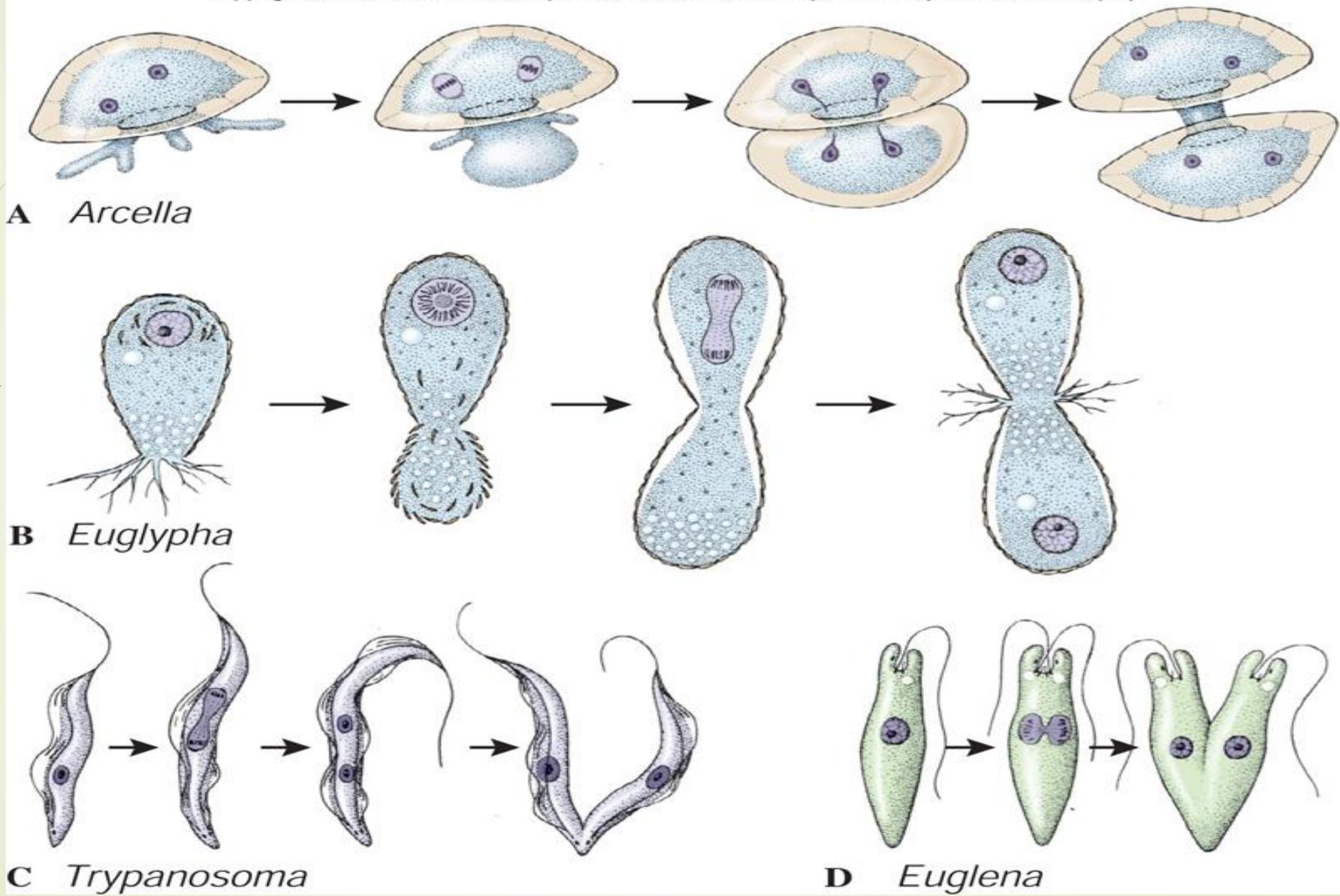
Reproduction in protozoa

- The commonest form of reproduction is **binary fission** in which two essentially identical individuals result.
- In some ciliates **budding** occurs in which a smaller progeny cell is budded off which later grows to adult size.



Binary fission
in various taxa

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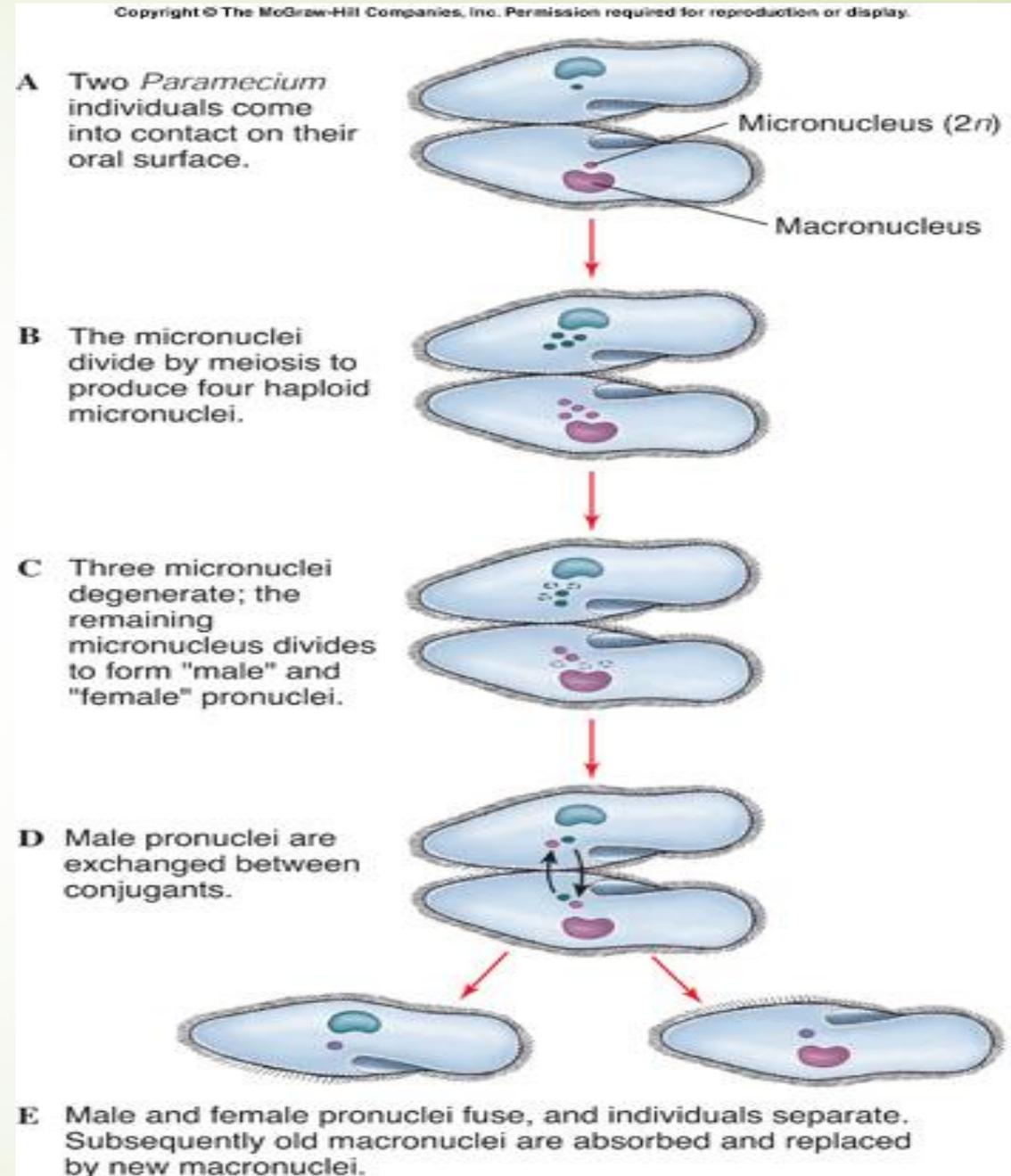




Sexual reproduction in protozoa

- All protozoa reproduce asexually, but sex is widespread in the protozoa too.
- In ciliates such as *Paramecium*, a type of sexual reproduction called conjugation takes place in which two paramecia join together and exchange genetic material

Sexual reproduction



Protozoan Parasites of Humans

➤ Ciliates

- Protozoa that use cilia in their trophozoite stage
- *Balantidium coli*
 - Only ciliate known to cause disease in humans
 - Commonly found in animal intestinal tracts
 - Humans infected by food or water contaminated with feces containing cysts
 - Trophozoites attach to mucosal epithelium lining the intestine
 - Infections generally asymptomatic in healthy adults
 - Balantidiasis occurs in those with poor health
 - Persistent diarrhea, abdominal pain, and weight loss

Protozoan Parasites of Humans

➤ Amoebae

- Protozoa with no truly defined shape
- Move and acquire food through the use of pseudopodia
- Found in water sources throughout the world
- Few cause disease

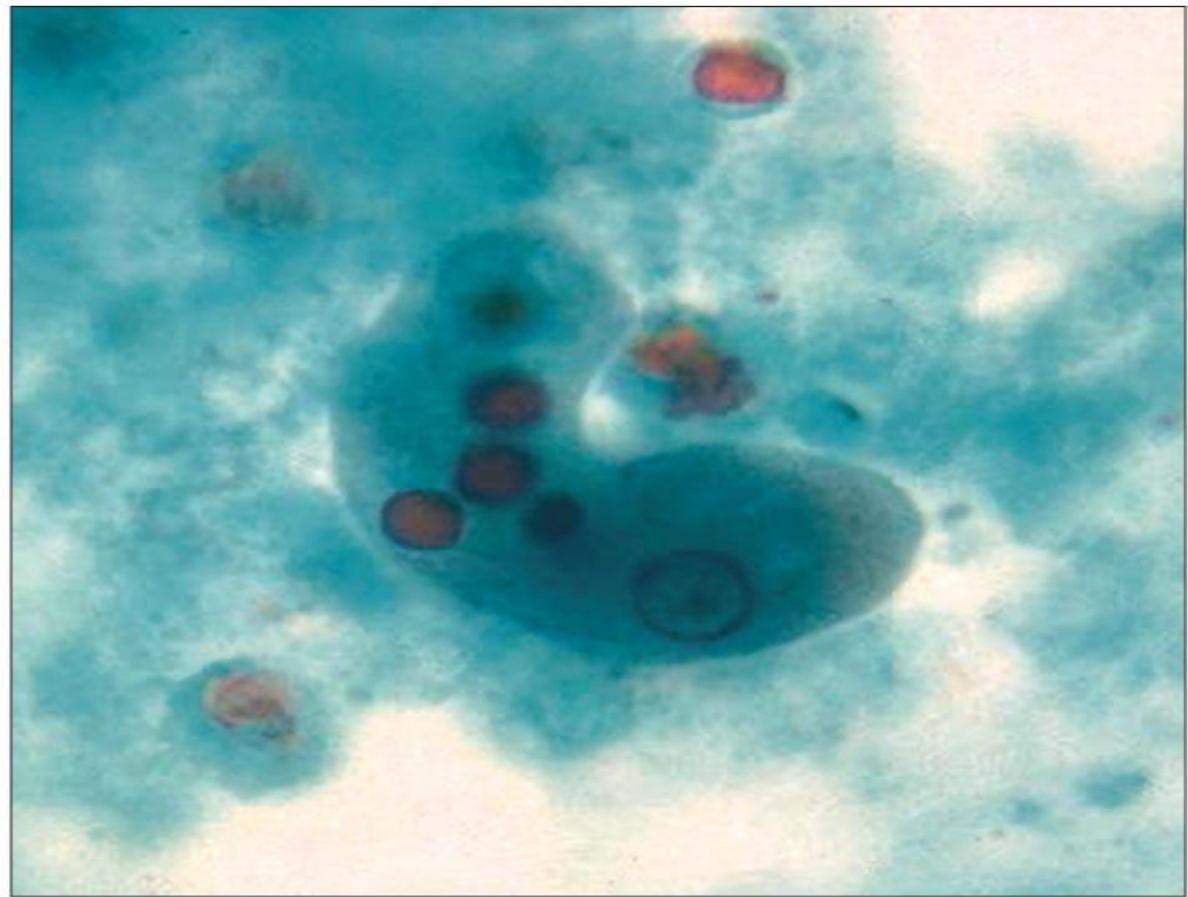
Protozoan Parasites of Humans

➤ Amoebae

➤ *Entamoeba*

- Carried in the digestive tracts of humans
- No animal reservoir exists
- Infection occurs by drinking water contaminated with feces containing cysts
- Maintaining clean water is important in prevention

Trophozoite of *Entamoeba histolytica*



LM 50 μ m

Protozoan Parasites of Humans

➤ Flagellates

- Protozoa that possess at least one flagellum
- Number and arrangement of flagella important to determining the species
- The flagellates include members of the genera *Trypanosoma*, *Leishmania*, *Giardi*, and *Trichomonas*

Protozoan Parasites of Humans

➤ Flagellates

- *Trypanosoma brucei*
 - Causes African sleeping sickness
 - The insect vector is the tsetse fly
 - Humans usually infected when bitten by infected tsetse flies

The life cycle of *T. brucei*

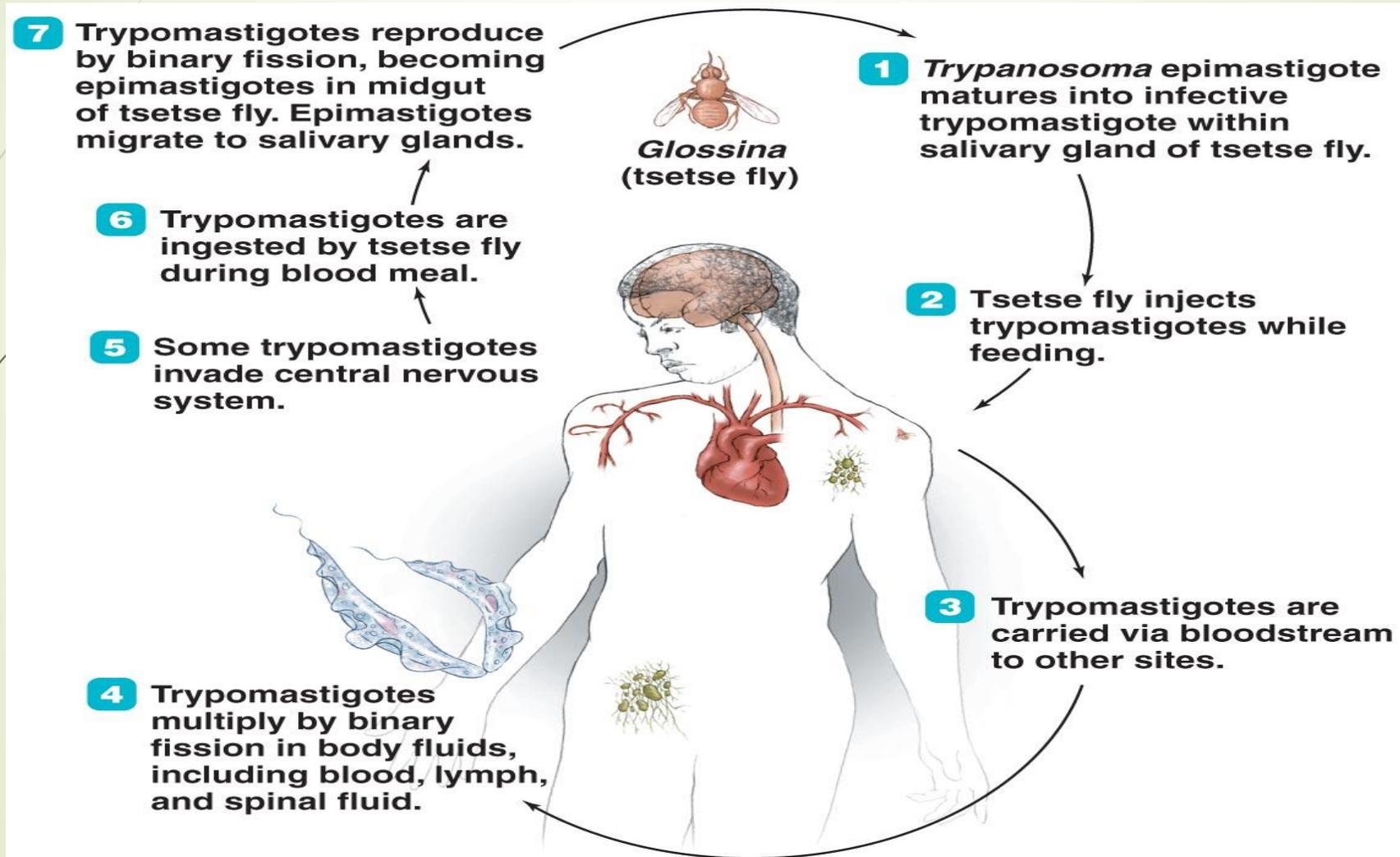


Figure 23.5

Protozoan Parasites of Humans

➤ Flagellates

- *Trypanosoma brucei*
 - African sleeping sickness
 - Progresses through three stages if left untreated
 - Site of the fly bite becomes a lesion with dead tissue
 - Fever, lymph node swelling, and headaches
 - Meningoencephalitis
 - Clearing tsetse fly habitats reduce the cases of disease

Protozoan Parasites of Humans

► Flagellates

- *Leishmania*
 - Causes leishmaniasis
 - Endemic in parts of the tropics and subtropics
 - Wild and domestic dogs and small rodents are common hosts
 - *Leishmania* have two developmental stages
 - Amastigotes
 - Multiply in host's macrophages and monocytes
 - Promastigotes
 - Develop extracellularly within a vector's gut

The life cycle of *Leishmania*

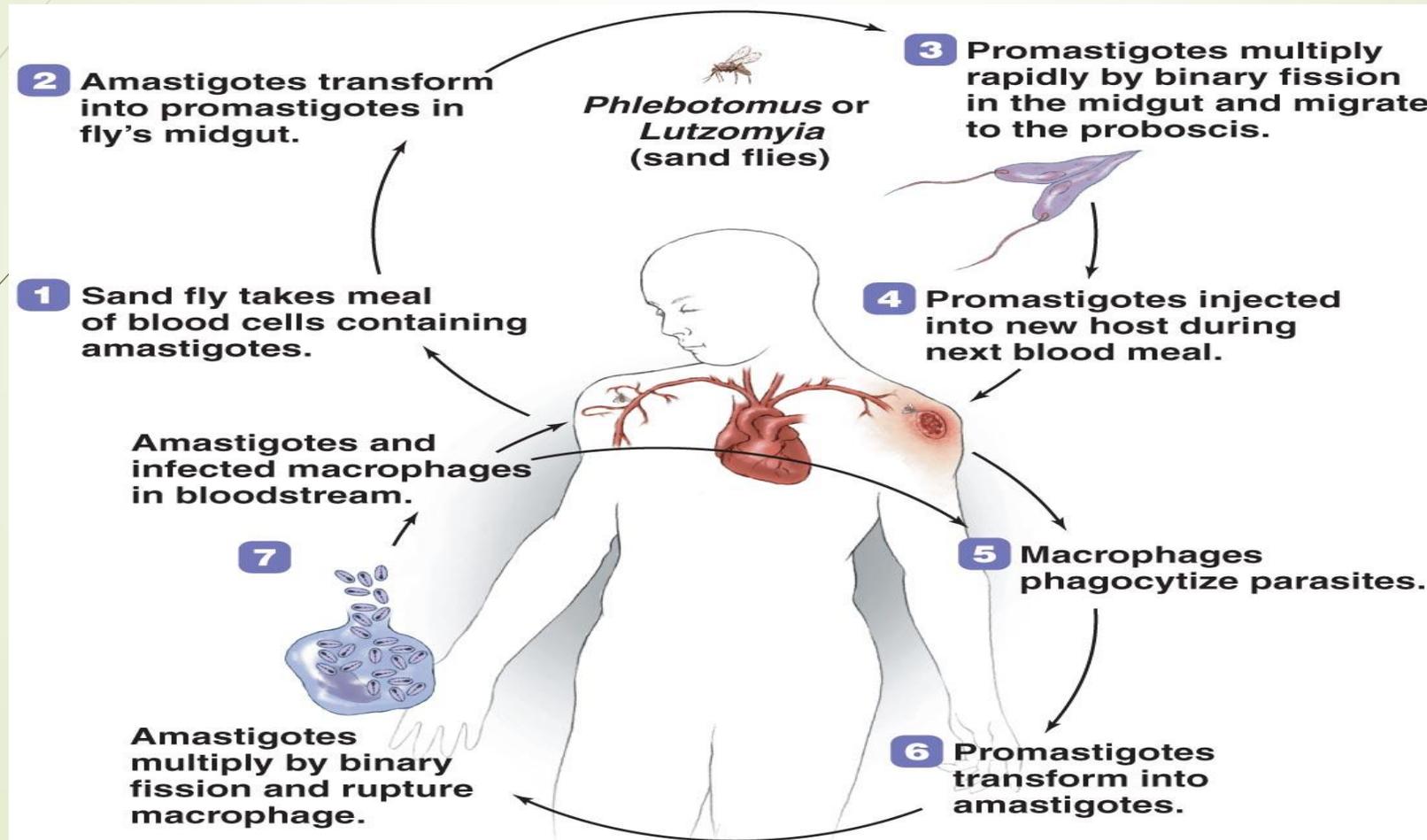


Figure 23.6

Protozoan Parasites of Humans

➤ Flagellates

➤ *Leishmania*

- Three clinical forms of leishmaniasis often observed
 - Cutaneous leishmaniasis
 - Mucocutaneous leishmaniasis
 - Visceral leishmaniasis
- Most cases of leishmaniasis heal without treatment
- Prevention limited to reducing exposure to reservoir and vector

Mucocutaneous leishmaniasis



Figure 23.7



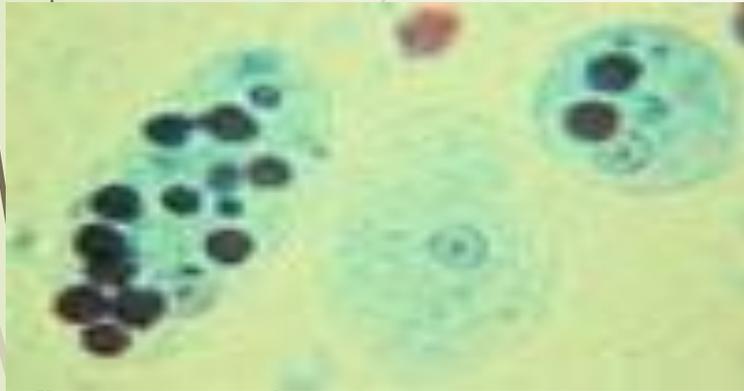
The Protozoa

Intestinal Protozoa - The Amoebae

General Life cycle -

- The definitive host ingests the infective cyst stage from fecal contamination in environment.
- The cyst passes into the small intestine & excystation occurs with transformation to the trophozoite stage.
- Trophozoites colonize the host, multiplying asexually via binary fission. They can remain near the lumen (non-pathogens) or invade the wall of the intestine & multiply (pathogens).
- Cysts and trophozoites are passed in the feces of the infected host.

The Protozoa



Intestinal Protozoa - The Amoebae

Entamoeba histolytica

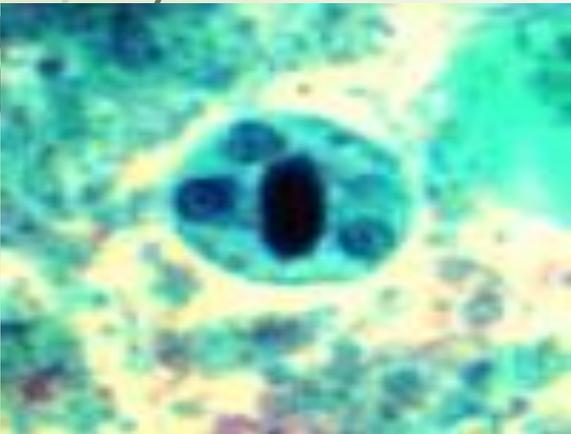
- **Epidemiology** - Occurs worldwide; the highest incidence and prevalence is in areas with poor sanitation.
- **Pathology and Clinical Manifestations** - the most pathogenic of all; causes amoebic dysentery; can become extra-intestinal; can be fatal. Hepatic abscess is the most common and dangerous complication.
- **Chronic infections** may last for years; often confused with colitis, cancer.
- **Distribution** - worldwide, mostly in tropics and sub-tropics.

The Protozoa

Intestinal Protozoa - The Amoebae

Entamoeba histolytica

- Morphology & Laboratory Identification - trophozoites range 12 to 30 microns in diameter; nucleus has an even distribution of peripheral chromatin and a small, compact, centrally located karyosome; cytoplasm is smooth and granular; inclusions, if present, are red blood cells; cysts range 10 to 20 microns in diameter and contains four nuclei when mature. Cigar-shaped chromatoid bars may be present in some cysts.



The Protozoa

Superclass Mastigophora - the flagellates. Inhabit the mouth, bloodstream, gastrointestinal, or urogenital tracts.

Morphological Characteristics

- **Flagellum(ae) - organelles of locomotion; an extension of ectoplasm; moves with a whip-like motion.**
- **Axostyle - a supporting mechanism, a rod-shaped structure; not all flagellates have these.**
- **Undulating membrane - a protoplasmic membrane with a flagellar rim extending out like a fin along the outer edge of the body of some flagellates.**
- **Costa - a thin, firm rod-like structure running along the base of the undulating membrane.**
- **Cytosome - a rudimentary mouth; also referred to as a gullet.**

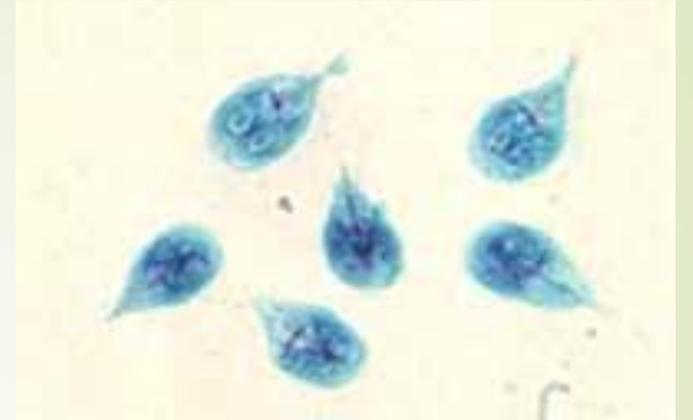
The Protozoa

Superclass Mastigophora - the flagellates.

Identification of a flagellate is based upon:

- ▶ **Size.**
- ▶ **Shape.**
- ▶ **Motility.**
- ▶ **Number and morphology of nuclei.**
- ▶ **Number and location of flagellae.**
- ▶ **Location in the body of the host.**

The Protozoa



Intestinal flagellates

Giardia lamblia

- Most common protozoan parasite in the U.S.A.
- Life cycle - man ingests cysts from fecally contaminated environment; the organism excysts in the upper intestine; trophozoites multiply and attach to the intestinal mucosa; often enter the gall bladder. Trophozoites and cysts are passed in the feces.
- Diagnosis - identification of cysts or trophozoites in stool specimens or duodenal contents.

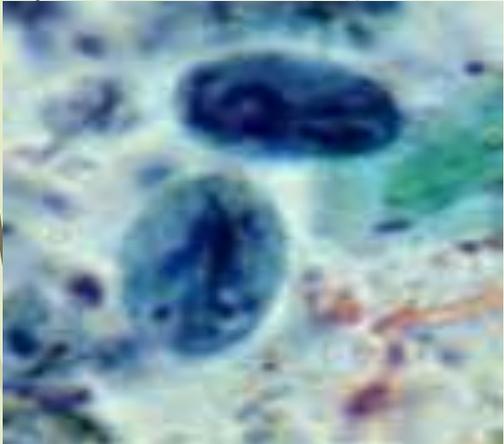
The Protozoa

Intestinal flagellates

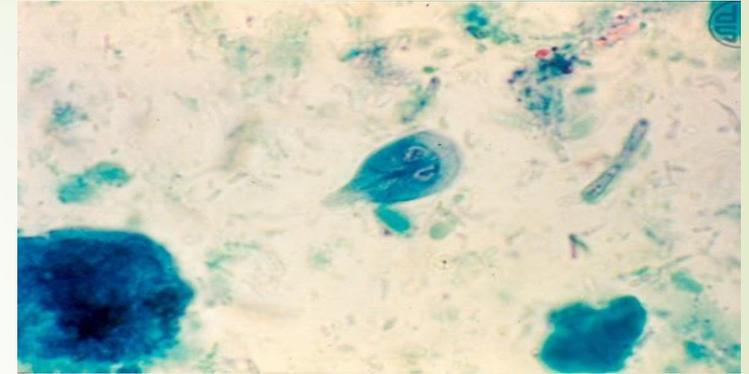
Giardia lamblia

Morphology - very distinctive. Dorsal-ventrally flattened, and Bi-laterally symmetrical.

- Cyst - 9 x 12 micrometers and contain 2 to 4 nuclei; parabasal bodies are present.
- Trophozoite - Four pairs of flagella - one pair located anterior, two pair located ventrally, and one pair located posteriorly. An axostyle and parabasal bodies are present.



The Protozoa



Intestinal flagellates

Giardia lamblia

- ▶ **Epidemiology** - prevalence 1 to 30%, common in children's day care centers; can be transmitted in water. Sexual transmission has been well documented.
- ▶ **Pathology and Clinical Manifestations** - symptoms can be severe; diarrhea, foul-smelling, greasy, mucus-laden stools, flatulence, nausea, cramps. Most infections are asymptomatic; chronic cases experience weight loss, malabsorption of fat, protein, folic acid, and fat-soluble vitamins.



The Protozoa

Class Ciliophora - The Ciliates

Balantidium coli

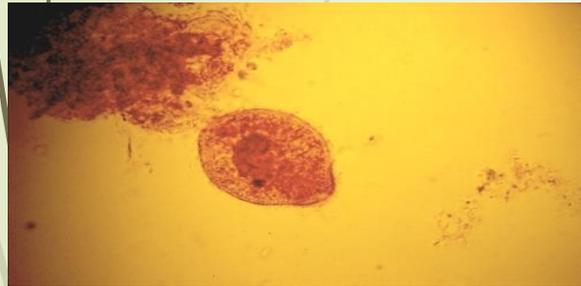
- Epidemiology - Rarely found in USA. This is the only ciliate parasite of humans.
- Largest parasitic protozoan - trophozoite is 30-120 x 25-125 microns; the cyst averages 50 - 70 microns in diameter.
- Life cycle - The cyst is ingested via fecal contamination in environment; cysts excyst in the small intestine; trophozoites migrate to large intestine.



The Protozoa

Class Ciliophora - The Ciliates

Balantidium coli



- **Pathology & Symptoms** - Many infections are asymptomatic, organism feeding on bacteria at surface of mucosa. Severe infections - with the aid of hyaluronidase, the organism burrows into submucosa, producing ulcers. Symptoms - dysentery, abdominal pain, nausea & vomiting, fever, headache.
- **Diagnosis** - Diagnosed by observing cysts & trophozoites in fecal samples.

The Protozoa

Class Ciliophora - The Ciliates

Balantidium coli

- Morphology - Large, oval shape; two nuclei, 1 large kidney shaped (macronucleus) & 1 small micronucleus (micronucleus not often seen); body surface covered by longitudinal rows of cilia; cytostome present.
- Primary animal reservoir - pigs, monkeys.

